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May-June 1951

METAL TREATING

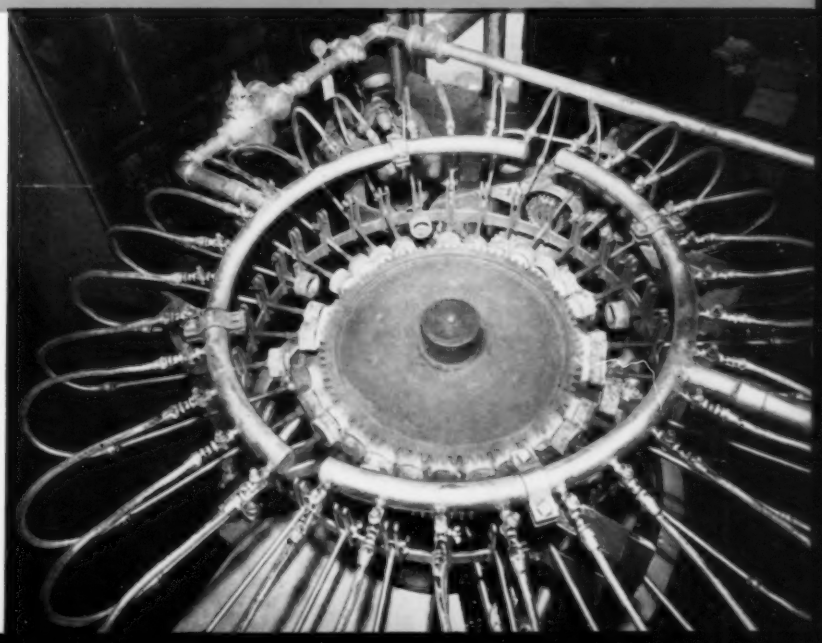
MTI MASTER CRAFTSMEN
METAL TREATING INSTITUTE

JOURNAL OF THE METAL TREATING INSTITUTE

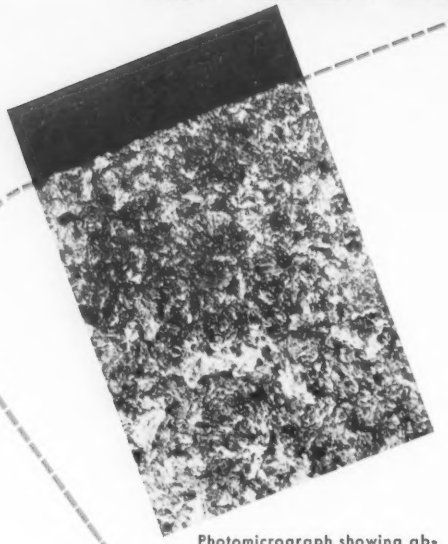
National Trade Association of

COMMERCIAL HEAT TREATERS

In the plant of the Pittsburgh Commercial Heat Treating Company (circle) the metal-working and metal-using industries find facilities for complete service. As an example the company developed a special radiant hardening machine (right) to local flame harden spur or bevel gear teeth up to 36" and 6" face.



SCALE FREE—DECARB FREE **Hardening for ALL Engineering Steels**



Photomicrograph showing absence of scale or decarburization in a section of S.A.E. 1085 steel (X100) neutral salt bath hardened at 1500°F. and quenched in oil. (Etched in 2% Nital.)

By its very nature the Ajax Electric Salt Bath Furnace guards against pitting, scaling, carburizing or decarburizing in the hardening of carbon, alloy, stainless and high carbon-high chromium steels in the temperature range from 1450° F. to 1950° F. The liquid neutral salt bath not only prevents these surface effects by sealing the work from air during heating, but leaves a protective film of salt on it right up to the moment of quenching. All need for "protective atmospheres," gas generating equipment and specially trained operators is eliminated.

Heating cycles are from 4 to 6 times faster than in atmosphere or radiant type furnaces, thus enabling small, relatively inexpensive salt bath equipment to handle an amazing volume of work. Heat is transferred by conduction rather than by convection or radiation, all surfaces of the work being in direct contact with the molten salt. Heating is extremely rapid and uniform. Distortion is reduced to a negligible minimum.

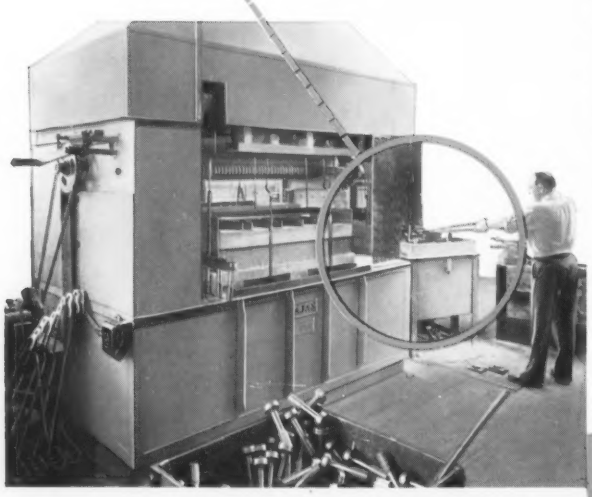
The unique internal heating principle of the Ajax furnace produces an automatic electrodynamic stirring action which contributes to rapid heating and assures a temperature variation of *less than* 5° F. throughout the bath.

Ajax furnaces assure low operating and maintenance costs and no skilled labor is required. Ceramic pots last 5 years or longer (many are still in use after 8 years continuous service).

AJAX ELECTRIC COMPANY, Inc.

WORLD'S LARGEST MANUFACTURER OF ELECTRIC HEAT TREATING FURNACES EXCLUSIVELY

940 Frankford Avenue, Philadelphia 23, Pa.



Automotive spline shafts being heated in a neutral salt bath equipped with a screw-conveyor mechanism. Temperature of the work is held within 5°F. even in this relatively large bath —6 ft. long, 2 ft. wide and 2 ft. deep.

SEE FOR YOURSELF!

Send or bring a sample batch of your work for salt bath hardening under actual shop conditions in the Ajax Metallurgical Service Laboratory. There is not the slightest obligation.

SELF-HEATING • SELF-CIRCULATING

AJAX HULTGREN **ELECTRIC SALT BATH FURNACES**

METAL TREATING

Official Journal of the Metal Treating Institute

Editorial...

LET'S PROFIT FROM EXPERIENCE

Under the present program for Defense Production, many manufacturers are faced with new and expanded heat treating problems. Their first thought is often to turn to the Government for financing the installation of new equipment, as was done so widely during World War II. In some cases this may seem unavoidable but it should be undertaken only after full consideration of all alternatives and recognition of the delays that will be encountered incident to establishing procedures, finding and training the personnel, and working out the "bugs" which always crop up in any new plant operation.

Because this was not done, great quantities of costly heat treating equipment – furnaces, pyrometers, control devices, atmosphere generators—were thrown on the market for disposal in the post-war period. Prices ranged down to the scrap value of the material. At the end of this road lie waste and business stagnation.

In most cases there is a better way. The first step should be for the contractor to get in touch with local Commercial Heat Treaters and determine whether one of these plants is capable of handling the heat treating requirements of the order. If then it is found necessary to create additional facilities, the economical place to do this is in the plant of an established, competent Commercial Heat Treater.

There are many reasons for this. He has that most important of all assets—trained, experienced personnel; the skills born of specialization. He has equipment suitable for a great variety of heat treating processes. He can usually expand his service rapidly when need arises. He has suitable testing and inspection facilities. He can advise his customer in connection with

(continued on page 21)

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Cooperate with Your Heat Treater for Best Results

By HERBERT DOBKIN
Ace Heat Treating Co.
Elizabeth, N. J.

Unfortunately, many people still consider heat treating to be a blacksmith's art and also, unfortunately, metallurgy is still an infant science. We have made much progress in the past few decades but we have a lot to learn. We still run into cases of identical parts processed at the same time in the same furnace showing variable results, and sometimes we just can't explain them.

I don't mean to sound pessimistic. From my experience I would say that the great majority of our problems can be overcome by suitable cooperation between the material supplier, the manufacturer, and the heat treater. However, this cooperation should start while the job is still in the blueprint stage. Many times we get extremely complicated parts, poorly designed, made of the worst possible material for the job. The customer warns us "this piece is finished to within a few thousandths of finished size; don't distort it." Well, that's pretty late to be "passing the buck" to the heat treater and, in spite of the warning, there is generally little he can do aside from exercising his usual care and discretion.

I've made a list of a few points which I consider important. I believe that if we cooperate on these, most of our troubles will be eliminated.

A. *Design*

This item is very important.

B. *Material Selection*

Proper material selection, before the job is started, is also important. *Both* your material supplier and your heat treater have a great deal of experience and knowledge on the subject which they are willing to pass on to you free of charge. Take advantage of their offer.

C. *Proper Identification of Materials*

If the heat treater could eliminate mixed-up steels he could eliminate 90% of his problems. Many times we get, say, twelve identical parts which are processed together. Eleven turn out perfectly but one does not. It is obvious from hardness, spark, color, etc., that the one bad piece is of a different material than the other parts, but the customer usually insists that they were all cut off the same bar. Upon checking further he discovers that twelve pieces were cut from the same bar originally but that one was spoiled in machining, and a replacement piece grabbed at random!

D. *Removal of Mill Bark (Scale)*

Adequate removal of all original mill scale and surface decarburization is very important. Not only must it be removed complete from all surfaces, particularly on tools and dies, but it must be removed uniformly. It is not sufficient, for example, to remove .030" on one side and only .010" on the other side. Since the decarburized layer has a different coefficient of expansion and contraction and a different set of critical temperatures from those of the metal underneath, it is obvious that failure to observe this precaution may lead to serious distortion, and even to cracking.

Memorandum of remarks by an MTI member, Mr. Dobkin, during a panel discussion at meeting of New Jersey Chapter, ASM, on February 19, 1951, on the subject "What About Heat Treating?" Other speakers were: Edward Murphy, Assistant Plant Manager, American Can Co., representing the tool designers; James Loiocano, Chief Metallurgist, Bendix Aviation, representing the plant metallurgists; Mr. Christoffersen, Assistant Chief Metallurgist, Curtiss-Wright, representing the metallurgical inspectors; and Edward Ryan, Metallurgical Engineer, Crucible Steel Co., representing the steel suppliers. The Editor of METAL TREATING feels that Mr. Dobkin's remarks will be of particular interest and value to Engineers, Purchasing Agents, and others, who send their work to the Commercial Heat Treating shop. Intelligent cooperation before heat treating avoids headaches.

E. *Distortion*

There are several steels on the market which are called non-deforming. Don't take this title too literally. Actually, they should be called "Relatively non-deforming." Any steel will show some movement during heat treatment. In general, this movement occurs due to two factors: first, the volume changes which take place during transformation and, secondly, the shape of the piece itself. As an example of the latter, everyone knows that a long, slender shaft will tend to bow during hardening.

Proper planning and processing in advance can minimize, if not eliminate, these difficulties. Stress-relieving between rough and finish-machining, if properly performed, can help a great deal. Intricately hobbed cavities should be stress relieved, not only between squeezes but also after the final squeeze. Sometimes we must resort to fixtures, but simple fixtures can usually be designed and built much more economically and quickly than trying to salvage badly-distorted parts.

F. *Incomplete Specifications*

If possible, don't just specify a desired hardness value, but try to give the heat treater an idea of the end-use for which the part is intended. Often it is possible to achieve a certain hardness in any one of possibly six different ways, only one of which is proper for the particular job. If you don't give the heat treater

this information, and if a part fails prematurely in service, in spite of being within the hardness range specified, don't blame him.

Don't specify hardness values too closely. Remember that two Rockwell machines, each of which checks with its own test blocks, may show variations from each other of as much as one to two points.

Don't take catalog values for obtainable hardness and hardenability too literally. Remember that these values are usually given for small-size test pieces, and need not necessarily apply to the larger sections which you may want treated.

G. *Failure after Heat Treating*

Even a perfectly hardened piece can be ruined by faulty grinding. Even a perfectly hardened and ground piece may fail prematurely in service due to over-stress, stress concentration, misalignments or improper clearances. When premature failures occur, please investigate those factors before jumping to the conclusion that the heat treating is at fault.

In general, these points cover the majority of problems which occur. Special cases may require special procedures. However, please keep one thing in mind —try to plan the job from the beginning in such a way that you consider not only your problems but also those of the heat treater and the steel supplier. Try to do the job in a manner which is easiest not only for you but also for them, and you will find it will work out to your mutual advantage.

"WE DESIGNED THAT FURNACE ON THE POP-UP TOASTER PRINCIPLE."

Trials of a Commercial Heat-Treater

The independent heat-treater is a popular whipping boy. Year in and year out he takes a lot of abuse. Yet we know from our own experience that heat-treaters are often asked to do impossible things. Sometimes the tool design is poor, the wrong tool steel has been picked for the job or there is some other factor that the heat-treater cannot control. A lot of people seem to think that the heat-treater can somehow treat tools to overcome all the things that have been done wrong up to that point.

Last fall we ran into a situation, for example, in which a heat-treater was asked to harden seven dies of rather large size. These progressive dies, made by a tool shop out in the Middle West, were of high-carbon, high-chromium steel. This grade was selected because the tool maker had very good results on some smaller dies on which this same steel held to almost a zero size change in heat-treatment. The assumption was that the larger dies could be hardened with equal accuracy even though they were two or three times longer.

The heat-treater was not aware of the exact limitations under which he had to work. So he used a standard heat-treating procedure and thought he'd done a good job. Then the customer measured the hardened dies. The width had been held quite accurately, but the length of the dies was way over the tolerance. Brother, then the hair really began to fly!

The dies were about 8 in. wide, 1 in. thick and 18 in. long. Being multiple-stage dies, the longitudinal expansion made them useless. Worse still, the dies were scheduled to go into production in just a few days. There simply wasn't sufficient time to start all over. The only possible solution was corrective heat-treatment.

The heat-treater and the tool steel distributor went into a huddle. The tool steel wasn't to blame and neither was the heat-treater, but they both felt an obligation to pull the customer out of the jam—if they could. They began a series of treatments—annealing, requenching, and tempering at various temperatures. And finally a compromise was arrived at. Holding the width of the dies to within a fraction of a thousandth of its correct dimension, the length of the dies was brought back to within permissible size.

We know for a fact that more than a hundred extra hours were spent in coaxing these dies back to accurate sizes.

The tool maker made his deadline. The heat-treater neither expected nor received much credit for the loving care he lavished in the corrective heat-treatment. And despite the extra time required, his invoice covered only the standard charges.

Perhaps it's service like this that makes so many people expect miracles of the heat-treater.

TOOL STEEL TOPICS
Bethlehem Steel Company

New Quenching Methods Avoid Cracking—Improve Performance*

By J. H. CHAPMAN, *Superintendent*
Hollywood Heat Treating Co.
Los Angeles

Thousands of dollars are wasted every year in the metalworking industry because tools and other steel shapes, which cost a great deal to machine, crack in quenching or later fail in performance.

The internal stresses introduced by quenching are the results of (a) dimensional changes in cooling, (b) large temperature gradients between surface and center, and (c) the change in volume accompanying the change from gamma to alpha iron. If the steel is ductile, these changes cause slight plastic flow of the grains which relieves the stress. In high-carbon steels, where no plastic deformation takes place, these stresses may build up to a high value.

Two comparatively new heat treating processes which eliminate these hazards to a great extent are now coming into wider commercial use. These are "austempering" and "martempering," each of which leaves the types of steel upon which they are used in certain desired conditions.

Austempering Based on Quenching

Austempering is a process of interrupted quenching whereby high-carbon and low alloy steels of suitable composition and cross section are quenched in a bath maintained at a constant temperature between 400° and 800°F., and then held there for a sufficient period to transform the austenite isothermally into bainite.

For hardness within the 48 to 55 Rockwell C range this treatment yields a tougher product than that obtainable by conventional quenching and tempering. It also eliminates the possibility of introducing high quenching stresses, with possible distortion or cracking.[1]

Limitations of Process

The process cannot be used if a very hard martensitic structure is desired since it produces a structure corresponding to tempered martensite of the required degree of fineness, which is obtained by cooling rapidly to room temperature followed by reheating to 400°F. or above.[2]

At any temperature below the austenite transformation and above the temperature of about 400°F., where martensite is formed, the austenite transforms to pearlite of definite structure at a definite rate.[3] If, therefore, small specimens of high-carbon steel are heated above the transformation temperature and are quenched very rapidly in a bath maintained at any intermediate temperature of from 400° to 800°F. and if the specimen is held in this bath for a definite time, the transformation of the retained[4] austenite and the resulting structure may be controlled closely.

Steels so treated are more ductile[5] than similar steels that are cooled rapidly to room temperature and tempered at a temperature that produces a corresponding structure. The hardness and strength of the austempered steel are about the same as if the steel had been quenched and tempered in the usual manner but elongation, reduction of area, and impact resistance are higher.[6]

The explanation advanced for the higher ductility in the austempered steel is its freedom from submicroscopic cracks that are caused by drastic quenching (to form martensite) and not subsequently healed by tempering.

Austempering is now being used on a *wide scale* commercially for the heat treatment of steel products of small cross section. To prevent any transformation of the unstable austenite to pearlite, the specimen must be small enough to cool down to the required temperature very rapidly. For example, certain types of carbon steel must be cooled at the rate of 1 second for each 100 degrees drop.

A member of the MTI Publications Committee offers the following comments to Mr. Chapman's article. The numerals refer to items similarly numbered in the article. Other readers' comments will be welcomed.

1. There is still room for debate whether a tougher product is obtained than can be obtained by the conventional quenching and tempering methods, under suitable conditions.
2. Technically, bainite is a different structure from tempered martensite.
3. Not strictly true. Pearlite forms isothermally only over about 1100°F.
4. It might be better to say "temporarily retained austenite."
5. See note 1, it still being debatable whether equal ductility cannot be obtained by tempering martensite.
6. The question of healing sub-microscopic cracks is still debatable.

Austempering and martempering are excellent processes, but are definitely limited to certain classes of work.

In contrast to the austempering process which avoids formation of martensite, a later process called martempering, developed a few years ago by B. F. Shepherd, features formation of martensite as its prime objective. In this process the steel is quenched at its critical rate —or faster—in a bath maintained at a temperature slightly above that where martensite starts to form so that it will drop in temperature without any transformation of the austenite.

Correct Temperature Important

This temperature varies with carbon content and slightly with the amount of alloying elements present, but for high-carbon and many alloy steels it is approximately 400°F. The steel is held in this bath just long enough for the temperature to become uniform throughout the cross section, after which it is removed and cooled in air. The steel should not be left in the bath long enough for bainite to form.

Martempering is based on the principle that, if

**Reprinted from* WESTERN METALS.

austenite is retained by rapid cooling down to the temperature where martensite begins to form, the austenite-martensite transformation will proceed regardless of the cooling rate from this temperature down to atmospheric temperature, and that on cooling slowly, as in air, from about 400°F., full hardness will result without the concomitant high interval quenching stresses which are characteristic of drastically quenched high-carbon or alloy steels.

According to Shepherd this treatment improves the mechanical properties, especially ductility and toughness. The method can be used for heavy sections and for pieces of irregular shape which often crack in the usual hardening operation.

Martempering resembles austempering only in that the quenching is interrupted at an intermediate temperature, but the steel is not held at this temperature long enough for any appreciable amount of the austenite to transform to the intermediate conditions.

In martempering, therefore, the austenite transforms to hard martensite while the steel is cooling slowly from this intermediate temperature to atmospheric temperature. In austempering the steel is held at intermediate temperature long enough for the austenite to transform to a ferrite-carbide aggregate of desired structure and properties.

Recommended Uses

For steel parts of complex shape or long slender sections, such as struts and oil well tools, we always recommend either the austempering or martempering heat treat procedures to our customers. Whether austempering or martempering is recommended depends upon the item and end result desired. The use of these two procedures will reduce the hazards connected with the heat treating of any steel part by more than 50%. Moreover, the parts come out of both of these processes very clean and free of scale.

Martempering is specially recommended for heat treating punches, dies, broaches, and other tools of complex shape where sharp corners and irregular form are likely to cause fracturing or later failure while in use, if the conventional method of quenching is used. It is also recommended for gears or any complicated part where a high degree of finished hardness is desired, as well as long shafting of small cross sectional area which is particularly liable to distortion.

Austempering is recommended where a finished product with more than the usual amount of elasticity is desired, such as light springs, fan blades, tube clamps, and clips.

While these two procedures take more time than the conventional quench they pay off with far fewer fractured or warped parts. The Hollywood Heat Treating Co. has spent a considerable sum during the past few years on the special equipment necessary to handle this work, but finds that it has been a wise investment which has helped secure greater customer satisfaction. We now are able to handle long sections and tubular parts up to 7 ft. in length, which is important because of the extreme difficulty in avoiding warpage when using the conventional process.

TWO VIEWS of a 7-ft. length of 4-in. OD tubing with ½-in. wall which has just been withdrawn from the furnace. At this stage of the martempering process the tubing has been soaking for an hour in the furnace at 1600° F. Prior to this it had been pre-heated for an hour at 1250°F. The tubing will now be quenched for approximately 20 min. in a salt bath in the quench tank shown behind the furnace in the lower picture, and then allowed to cool to room temperature. As a final step it will be drawn to the degree of hardness required.

Establish a Work Flow for Efficient Production

By W. W. Farrar, Jr.
Cook Heat Treating Corp.
Los Angeles, Calif.

Probably the most important adjunct to quality workmanship is the maintenance of a smooth work flow through the plant. Cook accomplishes this by the use of:

1. Work Cards.
2. Receiving Records.
3. Foreman's Flow Sheet (Daily Production Report).
4. Acceptance or Rejection Tags.
5. Combined Invoices and Shippers (Shipping Instruction Forms).

The procedure for processing jobs using the above materials is as follows:

When parts come into the plant a work card (Fig. 1) is made up from the customer's purchase order or delivery sheet. Work cards are varicolored: White—general; Blue—special handling; Pink—rush. All requirements specified by the customer are noted on this card along with other pertinent information such as diagrams (drawn on back), selective hardening and testing instructions.

If the customer submits no purchase order or written memorandum his oral instructions are recorded on our receiving record (Fig. 2). This information is transcribed to the work card in the same manner as above.

RECEIVING RECORD

Cook Heat Treating Corporation
LUcas 7241 5034 Alcon Ave.
Los Angeles 56, Calif. 19

CUSTOMER'S NAME

ADDRESS

PART NAME AND COUNT

SPECIFICATIONS:

Purchase Order No.

Requisition No.

DATE WANTED (A. M. / P. M.

Contact Mr. Phone No.

Fig. 2 — This Receiving Record is used in cases where no written Purchase Order is received.

CUSTOMER'S NAME | CUSTOMER'S ORDER NO. | OUR BLUE TICKET NO.

DATE RECEIVED | DATE WANTED | TIME WANTED ___A.M. ___P.M. | DELIVER ☐ WILL CALL ☐ | RESALE ☐ TAX ☐ | TENSILE WANTED ___ ___000

NUMBER PIECES | NAME AND NUMBER OF PART | WEIGHT EA. PC. ___ | HARDNESS WANTED ___TO___

MATERIAL | QUENCH WHERE: CONVEYOR ☐ DIE SHOP ☐ HYDRIZER ☐ PROD. SHOP ☐ ROTARY ☐ SALT BATH ☐ HEVI DUTY ☐ | QUENCH IN: OIL ☐ AIR ☐ WATER ☐ BRINE ☐ SALT ☐ | QUENCH TEMP. ___°F. HARDNESS AFTER QUENCH___ | 1st DRAW___°F. HARD___ 2nd DRAW___°F. HARD___ 3rd DRAW___°F. HARD___

CARBURIZE: PACK ☐ LIQUID ☐ GAS ☐ | CARB TEMP ___°F. CASE DEPTH T. B ☐ | COOL IN POT ☐ QUENCH DIRECT ☐ IN AIR ☐ OIL ☐ WATER ☐ | REQUENCH NO ☐ YES ☐ ___°F. IN OIL ☐ WATER ☐ | DRAW ___°F. IN LINDBERG ☐ SALT BATH ☐ | HARDNESS SHIPPED

ANNEAL ___°F. | PREHEAT ___°F. | NORMALIZE ___°F. | STRESS RELIEVE ___°F. | COUNT IN | COUNT OUT

COST | 100% Insp. ☐ | Sub Zero ☐

HOURS FOR QUENCH | HOURS FOR 1st DRAW | HOURS TO STRAIGHTEN | HOURS TO GRIND | HOURS TO INSPECT | HOURS TO WIRE | PRICE ___PER LB. ___EA.

STRAIGHTEN ☐ FROM QUENCH ☐ COLD ☐ | TOLERANCE

SKETCH ON BACK ☐ SANDBLAST ☐ LIQUID HONE ☐ ADDITIONAL INFORMATION ON BACK ☐

Fig. 1 — This Work Card produced in different colors to indicate handling requirements is the initial step in the "work flow" system.

At the day's end all purchase orders and receiving records are arranged alphabetically by the Receiving Clerk and the heat treating specification of *each individual order* from each customer is entered in like manner in the Foreman's Flow Sheet (Fig. 3). The purchase orders are then sent to the Shipping Clerk to be transcribed to the invoices and shipper forms the following morning. (When these purchase orders were entered in the Foreman's Flow Sheet each was marked with an X across the face to indicate to the typist that this operation had been performed and that processing on subject order has been started.)

COOK HEAT TREATING CORPORATION
DAILY PRODUCTION REPORT

DATE

CUSTOMER	NO. SHIPS	PART NAME AND NUMBER	SPECIFICATIONS	FOLLOW UP: QUENCH	DRAW	INSPECTION			REMARKS

Fig. 3 — The Foreman's Flow Sheet compiled as material is processed provides a complete record of each operation.

The Foreman's Flow Sheet, when completed, is placed in the Foreman's Office for ready reference by interested parties on the progress of any particular job at any time. Spaces are provided on this sheet for entry of categorical operations and results of these operations such as: (1) hardening temperature; (2) hardness from quench; (3) drawing temperature; (4) where drawn; (5) final hardness and acceptance or rejection of this hardness indicated by initials of the checker. As each operation is performed it is entered in its proper place in the flow sheet, thereby providing an accurate, accessible, up-to-date record of all current and past operations.

The work cards are made out as soon as the purchase order has been received and the work inspected for accuracy of count, forming defects and other factors which may affect heat treatment. These cards are then clipped to a board in the Receiving Department under the label of the department which will initiate the heat treating operations; for example, Pack Carburize Department, Production Shop, Cyanide Department, Tool and Die Shop.

When the interested foreman is ready to start the subject job he removes the card from this file, subsequently noting on it all operations as they are performed. This card follows the job through the plant and is consulted by all persons concerned with the performance of the work indicated on it.

When the final inspection has been made one of three cards is attached to the work; a green *acceptance* card containing customer's name, number of parts and hardness; or a red *reject* card containing above information along with reason for rejection; or a white *inspection* card showing preliminary inspection subject to customer acceptance. (Fig. 4.)

Cleaning operations subsequent to inspection such as sand blast, vapor blast or pickling are indicated on acceptance tag. When these parts are removed to the Cleaning Department the stub on the green tag is torn off and placed in an indexed file in the Shipping Department. When clean parts are returned to the Shipping Department the stubs are removed from the file and discarded. These stubs provide a ready clue to the location of parts to be cleaned. For example, if the Production Department indicates that subject job has been checked out for final hardness and the stub is not in the Cleaning Department file, the job would then be in only one of two places; the Inspection Department awaiting cleaning or in the Shipping Department awaiting shipment. This obviates a lot of unnecessary trips through the plant trying to locate a particular order.

This method of keeping plant records has proved to be very effective. By these various records a check and balance system is constantly active, helping to minimize error and maintain a smooth, machine-like flow of production.

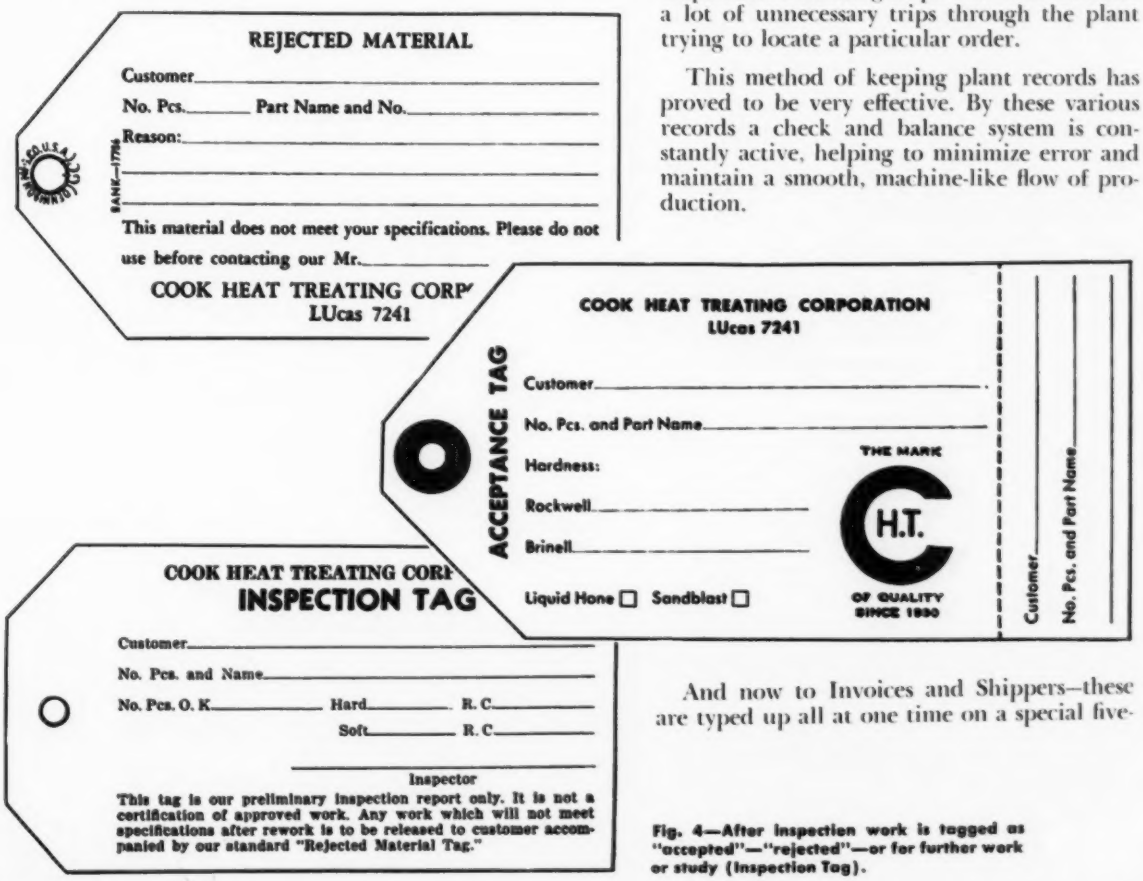

Fig. 4—After inspection work is tagged as "accepted"—"rejected"—or for further work or study (Inspection Tag).

And now to Invoices and Shippers—these are typed up all at one time on a special five-

SPEED UP

Pangborn

Hydro-Finish is versatile! Use it to speed up cleaning, polishing and finishing of molds and dies as well as production line work.

Hydro-Finish saves you time, labor and money. Scale and discoloration are removed in *minutes* instead of hours. Cleaned surfaces are virtually free of directional grinding lines. Costly hand work is greatly reduced. No danger of excessive metal removal because tolerances are held to .0001". Fine mesh abrasives suspended in water do a precision job.

Find out how Pangborn Hydro-Finish improves product quality, increases tool and die life! For full details, write today for Bulletin 1400A to: PANGBORN CORPORATION, 3600 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.

Pangborn

BLAST CLEANS CHEAPER
with the right equipment for every job

"QUALITY FIRST" HEAT TREATING · CARBURIZING · ANNEALING · CYANIDING · TOOL HARDENING · NITRIDING

ORIGINAL INVOICE

COOK HEAT TREATING CORPORATION
5934 ALCOA AVENUE LOS ANGELES 11 CALIFORNIA
LUcas 7241

DATE OF INVOICE
INVOICE NO.
YOUR ORDER NO.

QUANTITY	DESCRIPTION	AMOUNT

TERMS: NET

WE HEREBY CERTIFY THAT ALL GOODS COVERED BY THIS INVOICE WERE PRODUCED IN ACCORDANCE WITH PROVISIONS OF THE FAIR LABOR STANDARDS ACT OF JUNE 25, 1938 AND WALSH-HEALEY PUBLIC CONTRACTS ACT.
SUBJECT TO CONDITIONS SHOWN ON BACK OF THIS FORM.

Fig. 5 — The five-part invoice sheet includes "shipper forms" containing all necessary information for billing, shipping or pick-up.

part form with throw-away carbons (Fig. 5). As soon as one is typed the invoice is separated from the shipper form and put in an alphabetized invoice file. The shipper is put in a shipper file, to be removed later by our truck drivers, to accompany parts to be delivered by us. They are, of course, also used by our Shipping Clerk for the signature of "Will Call" customers.

Jobs requiring Certification of Heat Treatment are made up from information on the work card (Fig. 6).

The variety of work passing through a commercial heat treating plant due to his specialization in specific metal treating services naturally complicates the establishment of real "production line" methods. However, from our experience as described, it is indicated that with the careful analysis of each individual job, its lay-out, equipment and major operations, that a standard work flow procedure will pay real dividends in reduced costs and better customer service.

CERTIFICATION OF HEAT TREATMENT
COOK HEAT TREATING CORPORATION
5934 Alcoa Ave.
Los Angeles 58, Calif.
LUcas 7241

Date _____ Certification No. _____
Customer _____
Customer's Order No. _____ Invoice No. _____
No. Parts and Name _____ Material Specification _____
Specification, Heat Treating _____

We hereby certify that the parts described above were given the following Heat Treatment and that temperatures and test results were obtained with standard approved methods.

Annealed	°F	Cooled in furnace to	°F
Normalized	°F	Time at Heat	
Quenched	°F	Time	Coolant
Drawn	°F	Time at Heat	
Hardness Test		% of pcs. Tested	

All processes involved in the production of these articles and requiring government process approval have been so approved and certificates are on file subject to examination.

Subscribed and sworn to before me this
_____ day of _____ 19__.
_____ Notary Public
In and for the County of Los Angeles, State of California
My Commission Expires _____

COOK HEAT TREATING CORPORATION
_____
Authorized Signature

Fig. 6 — A compact notarized "Certification of Heat Treatment" available to those requiring such statements.

Heat Treatment of Plastic Molds*

By David R. Edgerton

There are certain definite results expected of the heat treater when plastic mold parts are entrusted to his tender mercy.

1) Freedom from pits, nicks and imperfections on the mold surfaces.
2) Freedom from warpage, size change and cracking.
3) Freedom from surface washing or sinking in service.

Your heat treater, whether in your own shop or of the commercial variety can with proper care and by utilizing his years of experience go a long way toward assuring you of these "Three Freedoms."

But the best heat treater on Earth cannot remove initial imperfections inherent in the steel, nor can he overcome the cracking of a poorly designed mold part, nor make a die stand up in a service for which the material was never intended by the steel maker.

This then is a plea for cooperation, between the designer, steel supplier, heat treater and production

Fig. 1 — Controlled Atmosphere Carburizing Furnace.

engineer. Perhaps a production schedule must be met and there is a strong temptation to use a handy chunk of boiler plate. Before you do, check with your heat treater. A cracked die or one that warps too badly to be used, or one that "washes out" on the first run is a total loss. Excepting for simple sections or purely experimental dies, we believe that the die-sinkers time so far exceeds the cost of material and hardening that it is a poor gamble to use any but the best material available from the most reputable supplier.

There are four general grades of steel that should cover the requirements for any molding operation.

They are:—

1) Low carbon, straight carbon, carburizing steels.
2) Low carbon, alloy, carburizing steels.
3) Through hardening alloy steels.
4) Stainless and heat resistant alloy steels.

It is suggested that your stockroom problem be simplified as much as possible by keeping on hand only those grades which have been carefully chosen with the cooperation of steel supplier, designer, engineer, tool maker and heat treater. One steel chosen from each class should be sufficient to properly meet every mold requirement. Simplification will permit savings in inventory, lower machining costs due to familiarity with the steel and will help to prevent costly mixups in grades. Since each user of Plastic Molds has his own preference of Steels, Surface Hardness, Case Depth and Core properties, we will refrain from entering into the controversial subject. Sufficient to state that the modern trend is toward the use of medium or low carbon alloy steels carburized and hardened. Since compression molding requires maximum resistance to surface Erosion or Washing, the hardness of the case is usually kept between 55 and 59 Rockwell C—with core hardness relatively high—350-400 Brinell to prevent "Sinking"—under the tremendous pressures encountered. Injection Molding permits the use of lower case and core hardness—but carburizing is considered to be "good practice"—since the carburized surface polishes more readily and retains the polish in service.

The modern hardening room has at its command the essential equipment for securing freedom from surface defects, but such equipment must be operated by men of skill and experience.

Following is a brief outline of procedures and hints, for eliminating some of the difficulties encountered in each method of processing.

1) Molten Salt Baths:—

Surface protection of mold faces is assured by molten salt baths, provided the baths are checked periodically for chemical balance and that polished test specimens are run and inspected prior to the treatment of expensive mold parts.

Liquid baths do not lend themselves to "copper masking" as the cyanide attacks the coating and the cyanided surface is difficult to machine even after air cooling.

While salt baths may be used successfully in hardening the "Through Hardening" mold steels, they have certain disadvantages which bear consideration. Aside from the careful control of the bath, care must be exercised to prevent contact with electrodes which will cause melting and pitting of mold surface. Then too, a certain amount of the salt will cling to the mold part, acting as an insulator, and in certain cases may prevent proper cooling during the quench into salt or oil, with subsequent soft areas and deformation. Most salts tend to absorb moisture and parts treated from the salt bath

**Reprinted from* Heat Treating Hints *Published by Lindberg Engineering Co., Chicago*

must be cleansed immediately, usually followed by a mild acid wash to neutralize the basic salt and oil dip to prevent corrosion and pitting. Recent research in the polishing of mold parts would indicate some difficulty in securing extremely high surface finishes on liquid carburized molds, possibly due to the localized concentration of nitrides.

Aside from the speed of liquid bath carburizing, there seems little to recommend its use for Mold Parts, and the trend is definitely toward Pack or Gas carburizing.

2) Pack Carburizing and Hardening

Pack carburizing is best accomplished in tight alloy retorts, of sufficient size to permit a minimum of 4" space for compound around the mold and 6" on top. The cover should fit tightly and be sealed with fire clay. The polished surfaces may be protected with a thin sheet of plain brown wrapping paper. This burns to ash at the carburizing temperature but prevents adhesion of particles of tar or other impurities in the compound. A thin layer of "burned" or used compound may be packed against polished surfaces. Pure wood charcoal of approximately "pea size" may be employed where high carbon cases are not objectionable.

Wet or unburned compound against a polished surface is disastrous and will cause pitting. Compound should be dried and the pack carburizing box should be placed in the heated furnace immediately to prevent the formation of sulphurous vapors which will etch the polished surface. Pack carburizing lends itself to masking and portions of molds may be left soft by plating with copper or by leaving sufficient metal on the surface for machining off the carburized skin after carburizing and prior to hardening.

Through hardening steels may be treated in packs by the same method as the carburizing grades except that a neutral compound is employed such as clean cast iron borings or burned pitch coke. Besides the use of brown paper, plating of the mold surfaces may be employed. Approximately .0005" to .001" of copper plate, deposited very slowly and with low amperage to prevent "spongyness" is effective.

Original porosity of the copper plate or graphite adhering after carburizing may cause pitting in subsequent "deplating" or stripping operations. It has been found wise to mechanically clean or soak the plated parts in hot caustic soda prior to electrolytic strippings of the plate.

The controlled atmosphere furnace (see Fig. 1) when available seems best suited for hardening the through hardening grades followed by a quench into the appropriate medium, tempering to the required hardness in forced air convection draw furnaces and liquid honing or electrolytic polishing to remove the adhering surface oxide. The controlled atmosphere furnace seems also to best fit the requirement when original molds have been carburized only and must be reheated for hardening.

Gas carburizing has been successfully employed for casing the carburizing grades. The casing action is somewhat faster than is pack carburizing, but great care must be exercised in properly controlling the gas analysis and rate of flow to insure a uniform case and freedom from soot deposits and consequent "soft spots."

Selective carburizing is possible during the casing by use of copper plate or paint. Increased wear resistance may be secured by increasing the Nitrogen content of the gas mixture. However, the gas carburizing or carbo-nitriding must be very carefully controlled since slight variations in gas analysis may cause uneven or low carbon casing. It is always wise to insert test pieces of similar steel adjacent to the mold part during the carburizing cycle, as an indication of case depth and hardness to be expected. While gas carburizing has definite advantages over pack carburizing, it is not nearly so "fool proof" and should be employed only under expert control.

Size change and warpage are variables requiring the complete cooperation of the steel supplier, the designer and the hardener. So-called non-deforming steels may be sadly disappointing to the mold maker since they very definitely can and will deform under certain conditions.

1) Non-uniform structures can cause deformation. This non-uniformity may be minimized by (a) oil quenching and annealing (b) normalizing and annealing prior to machining. As an example (see Fig. 2), the mold cavity shown grew .040" in the 18" length after standard oil quench and draw. After pack annealing and reworking to a larger size, it grew .014".

2) Underheating or overheating can cause distortion. These variables can only be corrected by proper inspection of temperature controls and by common sense on the part of the hardener.

3) Machining may cause size change. This is particularly true in reamed or bored holes. Drills, reamers or boring tools may *peen* or tear the metal causing growth or shrinkage as the deformed metal adjusts itself under heat.

4) Design may cause distortion in either carburized

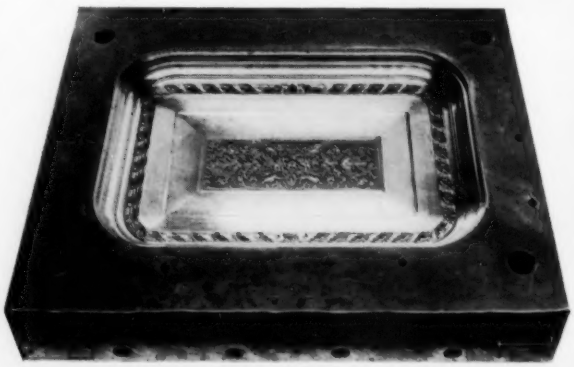

Fig. 2 — Polished Mold Cavity 24"x20"x5" Carburized Hardened.

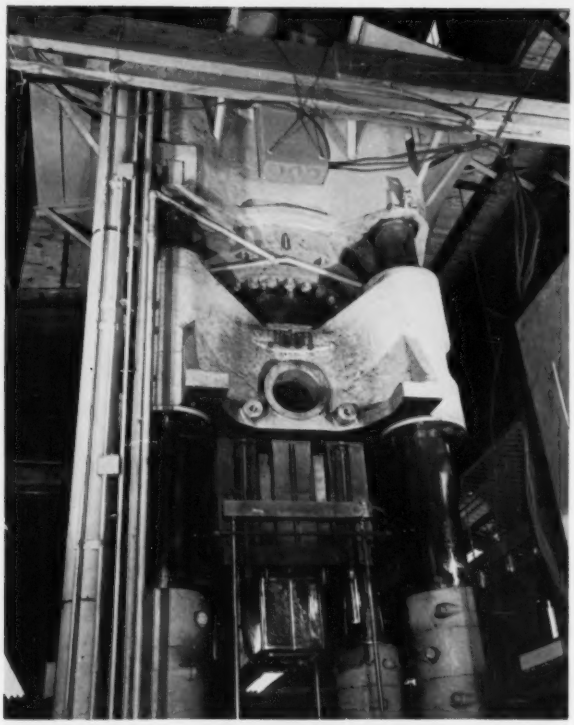

Fig. 3 — This giant press at Molded Products Company, Chicago, produces a complete television console cabinet for Admiral Corporation in one 6 minute operation. Preheated phenolic bricks are placed in the mold and subjected to more than 2,000 tons pressure. Within a few minutes a 35 pound bakelite casting, the world's largest has been produced. Economy of the process enabled Admiral to be first on the market with a complete console which at the time the process was first introduced, sold for $100 less than any comparable set on the market. This mold was heat treated at Lindberg Steel Treating Company, Chicago.

or through hardening steels. Thin sections adjacent to heavy sections, holes close to surfaces with thin sections of metal, sharp reentrant angles, or unbalanced sections, all may cause warpage or cracking due to uneven expansion and/or shrinkage during the hardening operation.

Let's get back to our first "Freedom": Freedom from surface defects.

You can help your hardener by purchasing only disc inspected material. As a check, you can at small cost install a lead or lead lined tank for your own disc inspection. A tank of suitable size is heated on a standard hot plate. ¼" to ½" thick discs are immersed in a 50/50 mixture of Hydrochloric Acid and water heated to 160°F. and held for 20 minutes. Discs are washed, dried and examined for slag, pits, segregation, or other defects. Mold blocks too large for immersion may be smooth machined including cavities and etched with Nital (10% Nitric Acid in alcohol) or a 5% solution of ammonium persulfate in water. Either solution may be sponged on the semi-finished mold surface with rag or cotton swab and the slight etching action will show up imperfections without damage to the mold or to the operator's hands.

Assured that the steel is sound, the part should be cleaned thoroughly of grease, lapping, compound and other residue after the final polishing and prior to hardening.

Nicking of polished mold surfaces through carelessness or unavoidable accident is the heat treater's "bugaboo." Only through exercise of every precaution in handling can such defects be eliminated. In most cases it is economical to pack finished mold parts in sturdy wooden containers with suitable lids even for transporting between departments. A $5 packing box may save $500 worth of grinding and polishing time in removing nicks.

In conclusion may we repeat the satisfactory treatment of mold parts depends on:—

1) Proper selection and quality of material.
2) Proper design.
3) Cooperation between designer; tool maker, and heat treater on size change allowances and pretreatment.
4) Good hardening equipment operated by experienced hardeners and properly controlled.
5) The utilization of every bit of available knowledge, care and experience—during the entire processing.

ALFRED HELLER
HEAT TREATING CO.

SILVER FINISH

NO SCALE • NO CARBURIZATION • NO DECARBURIZATION

SATIN FINISH - HELLERIZING
LIQUID HONING - BLACK MAGIC

Tool and Spring Steel Hardening • Controlled Atmosphere Hardening
Case Hardening • Carburizing • Hydrogen Annealing

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Institute News . . .

A Mid-West Regional meeting of members of the Metal Treating Institute was held in Chicago on April 27. The following companies were represented:

American Steel Treating Co., Crystal Lake, Ill.
Chicago Steel Treating Co., Chicago, Ill.
Dura-Hard Steel Treating Co., Chicago, Ill.
Eklund Metal Treating, Inc., Love Park, Ill.
Harris Metals Treating Co., Racine, Wisc.
Hushek Metal Processing Co., Milwaukee, Wisc.
Lindberg Steel Treating Co., Chicago, Ill.
Metal Treating, Inc., Milwaukee, Wisc.
O. T. Muehlemeyer Heat Treating Co., Rockford, Ill.
Pearson Industrial Steel Treating Co., Chicago, Ill.
Perfection Tool & Metal Heat Treating Co., Chicago, Ill.
C. U. Scott & Son, Inc., Rock Island, Ill.
The Fred A. Snow Co., Chicago, Ill.
Spindler Metal Processing Co., Racine, Wisc.
Thurner Heat Treating Co., Milwaukee, Wisc.
Wesley Steel Treating Co., Milwaukee, Wisc.
Wesley Heat Treating Co., Milwaukee, Wisc.
Wesley Metal Treating Co., Racine, Wisc.

The meeting was also attended by Walter Rex of the J. W. Rex Co., Lansdale, Pa., President of the Institute.

Discussion in addition to certain local matters centered about the activities of the Metal Treating Institute as a group and the work being done on behalf of the membership through contacts with the Department of Commerce and the Department of Labor. Action has been taken and is still in progress to achieve the establishment of the criticality of the occupation of "heat treater." Mr. Rex pointed out that the Institute has been in constant touch with regard to price controls and material allocations and at the time of the meeting was attempting to secure a ruling* as to the status of commercial heat treaters under CPR 22 "Manufacturers' General Ceiling Price Regulation."

Some discussion of the program for the Metal Treating Institute Spring Meeting scheduled for May 27-30 at Glenwood Springs was also held.

The group also expressed their appreciation of the fact that Frank Rizzo, L-R Heat Treating Co., Newark, N. J., turned over to METAL TREATING the entire mailing list of a similar trade magazine formerly published by him.

The meeting wound up with a further discussion of the Institute's publication METAL TREATING, its new circulation policy and plans for the future.

**Editor's Note:*

Since the meeting the Metal Treating Institute received the following telegram completely clarifying the industry's status:

"Washington, D. C., May 8, 1951 11 A.M.
INFORMED BY OPS THAT INDUSTRIAL HEAT TREATING PLANTS PROVIDING TREATMENTS FOR METAL PRODUCTS MANUFACTURED BY OTHERS NOT UNDER CPR 22 AND DO NOT HAVE TO SUBMIT OPS BASIC FORM 8. COMPANIES PERFORMING HEAT TREATING SERVICES ON OWN PRODUCTS COME UNDER OPS' NEW MACHINERY ORDER CPR 30. OPS CONSIDERING ISSUING NEW REGULATION SIMILAR TO CPR 30 FIXING PRICES FOR INDUSTRIAL SERVICES PERFORMED FOR METAL AND METAL PRODUCTS WITH EXCEPTION OF AUTOMOBILES AND FARM EQUIPMENT."

* * * *

NEW MEMBERS

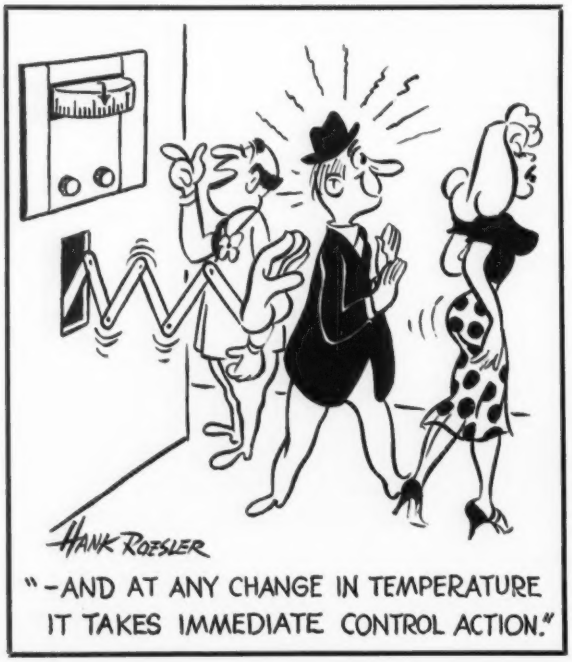
The Board of Directors and members of the Metal Treating Institute welcome to the organization the following new members whose applications have been accepted:

Paulo Products Co., 5711 West Park Ave., St. Louis 10, Mo.

Ferrotherm Co., 1861 E. 65th Street, Cleveland 3, Ohio.

Dexter Metal Treating Co., 1026 - 77th Avenue, Oakland 21, Calif.

The continued growth and success of the Institute will be assured by the active cooperation of these and other members; cooperation, according to Webster, being "the act of working together for the same end."



THERMO-COUPLETTES . . .

The Nitriding of High Speed Steel Tools in No. 90 Casing Salt

The cutting ability and effective life of most high speed steel tools can be improved easily and inexpensively by treating them in No. 90 Casing Salt according to Park Chemical Co., Detroit, Mich. This treatment produces a glass-hard "case" of iron-nitride on the tools which enables them to cut faster and smoother with fewer grinds and less stock removal per grind. The treatment is especially advantageous on tools operating at high speeds on relatively soft materials where smooth finishes are desired. Nevertheless, it improves the performance of almost all high speed steel tools except those subject to impact or heavy intermittent cutting. In any case, the treatment rarely affects tool life adversely. It is also said that high carbon—high chromium tool steels, which have been heat treated to develop secondary hardness, are also frequently improved by treatment in No. 90 Casing Salt.

Hardened and tempered high speed steel tools are treated in this casing salt at temperatures slightly below the final tempering heat after they have been "finish-ground." Somewhat higher temperatures may be used if a reduction in hardness of the tools is desired. Since the temperature of nitriding serves as an additional draw, the benefits of "casing" and double-drawing may be combined, if desired. No. 90 Casing Salt is not recommended as a tempering bath for the time cycles commonly used for the first draw. The treatment should be applied after each grind if stock is removed from the cutting surfaces of the tools. Some operators retemper at a low heat (700° to 1000°F.) after nitriding. The tightly adhering, microscopically thin, black oxide formed by treatment in salts, like LTDS, HTDS, or Draw Black, at those temperatures, is considered beneficial from a "breaking-in" and lubricity standpoint. Various combinations of these casing and blackening treatments are being applied to high speed steel tools as "secret processes" for improving them, under a variety of trade names.

Tools to be nitrided should be clean, dry, and neither decarburized nor carburized. The former condition promotes brittleness and the latter may prevent the nitriding action. Times of immersion in the salt depend on the tools to be treated. Small tools come up to heat faster than large tools. Tools with fine edges should be run at shorter times than those with coarse cutting edges. Tools that wear in service require longer times in the casing bath; chipped cutting edges are an indication that shorter times should be used.

Preheating of the work is not necessary except for accurate control of time at heat in the salt bath. Quenching from the nitriding heat in oil or water is dangerous; cooling in air or an air blast is recommended. After the tools reach room temperature, the salt is easily washed off with hot water. Large tools, which require more cooling time than tools of small section, occasionally show a reddish-brown or black scale after washing. High humidity promotes this condition. Forced air cooling and hot oil quenching alleviate the condition. Since it is actually oxidation during cooling, redipping the cooling tools in the salt after they have been out of the bath for a few minutes, forms a thicker and more protective film of salt to resist oxidation during subsequent cooling to room temperature.

Shown below is a table of suggested times for various tools, but individual experience is the best standard.

SUGGESTED TIME IN BATH

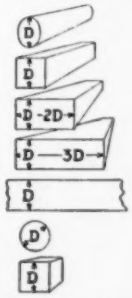
CUTTERS	
¼"	15-30 min.
½"	30-45 min.
¾" to 2"	45-60 min.
REAMERS	
¼"	10-20 min.
½"	20-30 min.
¾" to 1"	35-60 min.
DRILLS	
¼"	10-20 min.
½"	20-30 min.
¾"	30-45 min.
HOBS	
Up to 1#	20-30 min.
1 to 2#	30-40 min.
2# up	40-60 min.
TAPS	
Up to ½"	10 min.
¾"	10-15 min.
FORM TOOLS	
¼"	15-30 min.
½"	30-45 min.
¾"	40-50 min.

* * * *

Effect of Shape on Heating Time

By a rather complicated mathematical calculation, it is possible to work out a theoretical ratio like the following for all simple shapes. The calculated values checked quite closely with values determined by actual test. Here are the figures summarized:

RELATIVE HEATING SPEED OF VARIOUS SHAPES COMPARED TO A LONG CYLINDER (1)



Shape	Speed Factor
Long cylinder (dia. = D)	1
Long square (D x D)	1
Long rectangle (D x 2D)	.7
Long rectangle (D x 3D)	.6
Infinite plate (very wide, thickness = D)	.5
Sphere (dia. = D)	1.5
Cube (D x D x D)	1.5

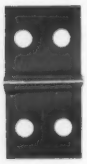
(1) These calculated factors were furnished by Mr. Howard Scott, and permission to use them here is gratefully acknowledged.

To use this table it is necessary to know how long it would take a cylinder to heat under the particular conditions at hand. Then to determine the time for the other shapes, *divide* the time of the cylinder by the "speed factor" for the new shape. For example, if

(continued on page 14)

New!

BLACK OXIDE PROCESS
for STEEL and IRON



BLACK MAGIC
(TYPE A)
Pat. Pending

★ **Easily blackens heat treated parts.** BLACK MAGIC Type A overcomes the difficulties normally present in applying a black oxide finish to cyanide hardened pieces, which have been oil quenched, and carbo-nitrided parts.

★ **One bath! One salt!** BLACK MAGIC Type A blackening process requires only 1 bath. The same salt mixture that makes up the initial solution is used to replenish dragout losses, thus maintaining at all times a true, chemically balanced BLACK MAGIC solution. Only 6½ lbs. of BLACK MAGIC salts are required to make up each gallon of solution.

★ **Lower operating temperature.** BLACK MAGIC Type A solution is operated at a boiling point of only 290° F. This substantially decreases the amount of dragout and effects important savings in heat consumption. The higher fluidity of the BLACK MAGIC solution lowers operating costs considerably.

★ **Self rectifying.** BLACK MAGIC Type A overcomes the normal tendency in black oxide processes to build up red iron oxide in colloidal form which eventually clings to the processed work. BLACK MAGIC is so formulated to be self rectifying and under normal and many abnormal conditions will keep the bath in excellent operating condition at all times.

★ **Faster blackening cycle.** Production baths of BLACK MAGIC Type A show a decrease in the blackening time cycles of from 15 to 20%. This is an important factor in speed up in production and lower cost of operation.

★ **More corrosion resistant.** BLACK MAGIC Type A has high absorption and adsorption qualities for oils and waxes normally used as a final finish dip. This characteristic gives infinitely higher corrosion resistant qualities to the finished parts.

Write for Bulletin MB-3 *Send items of your own manufacture for sample processing.*

Also Manufacturers of
Heat Treating Salts (Carburizing — Neutral — Tempering), etc., Metal Cleaners, Rust-proofing Oils and Waxes, Metal Finishing Processes for Ferrous and Non-Ferrous Metals.

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Thermo-couplettes (cont.)

a long cylinder 1" round takes 30 minutes to heat, then a long flat measuring 1" x 3" would take 30 minutes divided by .6 or 50 minutes to heat; and a 1" cube would require 30 minutes divided by 1.5 or 20 minutes to heat.

From the CARPENTER SERVICE BULLETINS
Published by The Carpenter Steel Co., Reading, Pa.

* * * *

Lucifer Electric Furnaces Offered on Free Trial

Gilbert S. Simonski Company, 401 North Broad Street, Philadelphia 8, Penna., is now offering any of its line of Lucifer Electric Heat Treating Furnaces on free trial to qualified furnace users.

Any Lucifer furnace may be used for regular hardening, case hardening, drawing, tempering, etc. New types of electronic controls permit them to be brought to the desired heat slowly or rapidly as desired. Cooling time may likewise be controlled to exacting standards. All control and operating instruments are an integral part of the furnaces when delivered. An unconditional guarantee covers every unit shipped.

* * * *

Low-cost "Straight Line" Control

Wheelco Instruments Company, 847 West Harrison Street, Chicago, announce a new Capaciline "straight

(continued on page 22)

Tests show New Quench Oil has Intensified Triple Action

● A new accelerated quenching oil has been developed that gives (1) rapid heat removal with faster cooling rate in the hardening range, this results in higher and deeper hardness; (2) slow cooling below the hardening range, thus minimizing distortion; (3) greater stability due to special anti-oxidants, for longer life and bright quenching properties.

To better illustrate the manner in which this triple action quenching oil accomplishes this higher quenching efficiency, it will be well to show the three stages of cooling as observed when steel is quenched in oil from a red heat. These stages are:

A. Formation of a vapor film at the steel surface; cooling is accomplished by conduction and radiation through this vapor film and is relatively slow.

B. Direct contact of the oil with the metal surfaces, causing a boiling action which continually dissipates the vapor film formed and results in rapid cooling.

C. After the metal has been cooled to the boiling point of oil, vapor is no longer formed; cooling is by conduction and convection, and the metal slowly cools to the temperature of the oil.

It is apparent that any improvement in the cooling power of oil in stages A and B would be most desirable. This can be compared to the brine quench which is used instead of water. Brine has a wetting action that completes the quench faster than fresh water, which "takes hold" only in spots, causing non-uniformity. Salt brine solutions provide deeper and more uniform hardnesses. This results in deeper and more even hardnesses. It seems logical to attempt to do this same thing with oil. The mineral intensifiers added to this Triple A Quenching Oil act in this manner.

Practical Application of Quench Curves to Hardening Steel

The improvement of oils so as to effect this desired change in the cooling characteristics has been attempted in the past by blending mineral oil with animal oils, but the product was prone to become rancid, or to decompose on contact with hot steel. These blends were also unsatisfactory as quenching mediums for steel treated in certain types of salt baths.

Developed in the Research Laboratory of the Park Chemical Co., the Park Triple A Quench Oil, a blend of specially refined mineral oils, cools steel faster in the upper temperature range by shortening the duration of vapor stage (A) and intensifying the action of boiling stage (B). Heat removal in stage (C) is slow and uniform. Thus, the best surface hardness and depth of hardness penetration are achieved with no danger of cracking or distortion.

Extremely stable, this new accelerated quenching oil may be used as a quench from any heat treating medium without fear of rancidity, oil breakdown, or change in quenching efficiency. Further, Park Triple A Oil is especially suitable for obtaining the maximum uniform oil-quenched hardenability from low and medium alloy steels.

Results of the improvement are shown in chart below showing actual hardnesses in quenched pieces. There is a 16% surface hardness increase with Park Triple A Oil over a good grade of straight mineral oil. The effect would be greater when comparing it with some of the poorer grades of oil used for quenching. Center hardnesses of the one-inch diameter piece are up 14%. Lighter sections would show even more increases.

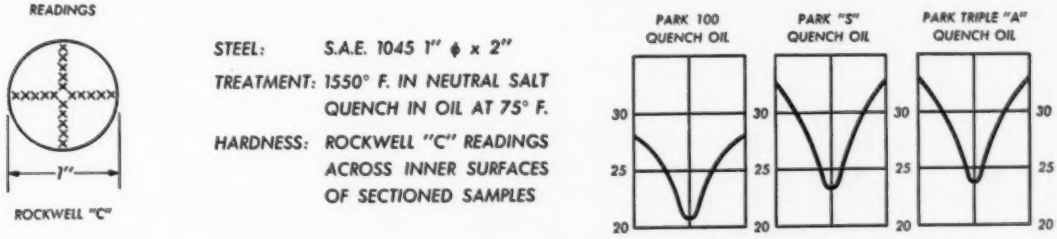
Bright Quenching and Stability

A very crucial and costly problem in the carbo-nitriding process has been the cleanliness of work after oil quenching. Oils which deteriorate rapidly or were originally unsuitable leave a sooty carbonaceous film on the surface of the work. This presents a difficult cleaning problem when followed by a plating or welding operation.

This difficulty, when not the fault of the furnace atmosphere, can be corrected by the use of Park Triple A Quench Oil.

Through the use of anti-oxidant additives and mineral intensifier it has been possible to prolong the bright quenching properties of good clean oil. Underwood Oxidation experiments have proven Park Triple A Quench Oil to have exceptional stability and long life.

A Bulletin, #F8, was prepared on Park's Triple A Quench Oil. It gives you a complete description of this oil with cooling curves, production data and photographs. Write Park Chemical Co., 8074 Military Ave., Detroit 4, Mich.


READINGS
1"
ROCKWELL "C"
STEEL: S.A.E. 1045 1" ϕ x 2"
TREATMENT: 1550° F. IN NEUTRAL SALT QUENCH IN OIL AT 75° F.
HARDNESS: ROCKWELL "C" READINGS ACROSS INNER SURFACES OF SECTIONED SAMPLES
PARK 100 QUENCH OIL
PARK "S" QUENCH OIL
PARK TRIPLE "A" QUENCH OIL
30
25
20

Transverse hardness Rc taken on 1" round SAE 1045 steel two inches long. Quench from Park's Nu-Sal neutral salt at 1550°F. into three types of quench oil, Park's No. 100 Oil (straight paraffin), Park's "S" Oil (compound with animal oil), Park's Triple A Oil. Oil temperatures 75° F.

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LETTERS TO THE EDITOR

Dear Editor:

Kindly send to us 25 reprints each of the articles, Manufacturing Applications of Liquid Impact Blasting, by B. H. Marks, and Engineering Properties of Iron Castings Can Be Improved by Heat Treatment, by C. E. Herington, which appeared in your March-April, 1951 issue.

J. F. ERVIN
President
Ervin Foundry & Manufacturing Co.
Ann Arbor, Michigan

Dear Editor:

I have had the pleasure to read your book on Metal Treating printed for the heat treaters. And since I am a heat treater I find the reading very helpful in making me a better heat treater. I would like to obtain this book, so will you please let me know what a year's subscription would cost?

I would be very appreciative if you would do that.

FRANK C. ALBERS
810 Brad Ave., S.E.
Canton 7, Ohio

Dear Editor:

We have received the September 1950 issue of Metal Treating and would like to be put on your mailing list to receive subsequent issues as issued.

This library is the library of the four Societies listed in our letterhead, having a combined membership of approximately 110,000 members. The material in this journal should be of particular interest to the members of the AIME and the ASME. We hope that you will be able to send it to us for the use of our members and also for the use of engineers generally since our Reading Room is open to the public.

RALPH H. PHELPS
Director
Engineering Societies Library
New York

Dear Editor:

This acknowledges receipt of March-April, 1951 issue of "Metal Treating." We wish to thank you for the very nice article you published concerning our Hydro-Finish Equipment. You may be assured this is greatly appreciated.

Please do not hesitate to call on us if we can be of service to you in any way from time to time.

B. H. MARKS, Mgr.
Hydro-Finish Division
Pangborn Corp.
Hagerstown, Maryland

Dear Editor:

Thank you for your letter of January 16 and your courtesy in putting us on the mailing list for METAL TREATING. This looks like an informative periodical and we will be glad to use it for the information of our Metallurgical Committee.

L. A. DANSE
Supervisor
General Motors Corporation
Detroit

Dear Editor:

Thank you for your letter of November 29 and the issue of "Metal Treating" which accompanied it.

I shall appreciate receiving copies of this publication in the future.

Thanks again for your cooperation in this matter.

W. A. STADTLER
Mgr., Technical Research
International Business Machines Corp.
Poughkeepsie

Dear Editor:

In the March-April issue of "Metal Treating" you mention an article by you and Mr. Sault called "Development of a Heat Treating Burden Rate."

This current issue of "Metal Treating" is the first one I've seen. Is there any way I may obtain a copy of your article on Burden Rate?

We are extremely anxious to establish a reliable, accurate, and simple, if possible, cost system for our Heat Treat Department.

GRANT W. LaPIER
Heat Treat Department
The Cleveland Graphite Bronze Co.
Cleveland

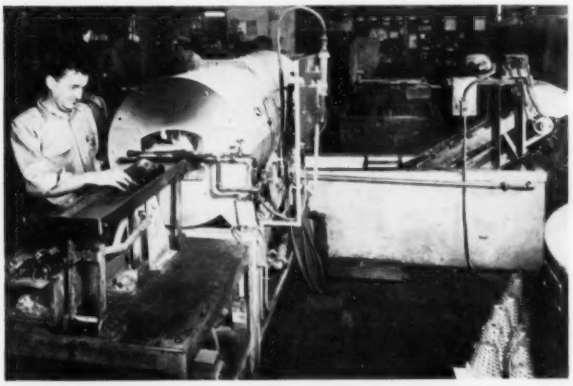
PERSONALS

Frank J. Rizzo, President, advises that L-R Heat Treating Co., Newark, N. J., has just purchased a 33-ft. cabin cruiser made by "Correct Craft."

* * * *

Clarence Graham, reports from Metal Treating, Inc., Milwaukee, that a Hevi-Duty Shaker Hearth Furnace, illustrated, has been in their plant about six months and is doing a nice job on small parts, running from 150 to 200 lb. per hour on springs, washers, studs, etc.

The conveyor was not made to handle large pieces, but Metal Treating, Inc., has made baskets that fit above the conveyor and attach to the quench chute. This allows quite large pieces to be processed.



The unit is compact and the fact that Hevi-Duty built the heating chamber in two pieces makes it possible to service the elements simply by lifting the top portion. The hearth is also easy to replace as it can be removed from the open end even while the furnace is hot.

This unit is equipped with generator gas, propane,

(continued on page 22)

AVAILABLE EQUIPMENT

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Annealing Furnace, Electric Furnace Co.

Gas-fired recuperative radiant tube heated special atmosphere type, with continuous roller hearth conveyor. Serial No. 2313-F designed for annealing to 1400 degrees F. Heating chamber 15'8" long, 3'6"wide, 11" high. Furnace includes gravity conveyor and control equipment. Has been used trial period only—immediate delivery.

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That's the oil that saved the day for so many metalworking plants during the critical shortage of alloying elements in World War II, by giving them a faster quenching speed through the critical zone.

Now it's even faster, assuring maximum hardness even with lean alloy steels—again a necessity.

Houghto-Quench is stable and long-lived. It may well be the answer to your quenching problem. Ask the Houghton man, or write us direct. E.F. Houghton & Co., Philadelphia 33, Pa.

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Manufacturers' Literature . . .

The literature listed below contains information of interest to heat treating organizations. For your copy write direct to the manufacturer and be sure you mention seeing it reviewed in "Metal Treating".

Testing Equipment

A 4-page bulletin entitled "Testing Instruments" published by Steel City Testing Machines, Inc., Detroit 4, Michigan, provides complete data and illustrations for various types of testing machines most of which are widely used in most heat treating plants. Both standard and special types of equipment are discussed.

Dust & Fume Control

The first issue of "Industrial Ventilation," a new periodical devoted to the latest developments in industrial dust and fume control, has just been published by American Wheelabrator & Equipment Corp., Mishawaka, Indiana.

This issue contains illustrated case histories on the application of Dustube cloth-tube filters to dust control problems in various industries. Of special interest to ventilation engineers is the informative technical discussion on the collecting efficiencies of cloth-type filters.

Future editions will present dust and fume control data and information applying to all segments of the chemical and metallurgical industries.

Copies of this publication will be mailed upon request. Write to the American Wheelabrator & Equipment Corp., 555 S. Byrkit St., Mishawaka, Indiana.

Laboratory Items

Scientific Glass Apparatus Co., Inc., Bloomfield, New Jersey, has just released a new 28-page edition of their publication entitled "What's New for the Laboratory"—No. 12 in the series.

Illustrated and described are a number of new, interesting items – including laboratory clamps of revolutionary design, a pail and dipper of special rubber-like material for handling corrosive chemicals, miniature type pumps, a handled beaker, a unique pocket-type thermometer, high-capacity glass condensers and adapters with metal coils—in fact, over thirty different items are covered.

To obtain your free copy of "What's New for the Laboratory," write directly to the Scientific Glass Apparatus Co., Inc., Bloomfield, New Jersey.

Heat Treat Review

A new publication, designed to present current technical and operating information on heat treating metallurgy and practice, has been instituted by Surface Combustion Corporation, Toledo, Ohio.

This bulletin, entitled the "Heat Treat Review," is to be published periodically by Surface Combustion and distributed to all persons concerned with heat treating operations. The magazine is intended to provide up-to-date information on heat treating processes as applied to all phases of the metal-working field. Metal melting and related metal processing activities are also to be covered in this bulletin.

Industrial metallurgists and heat treaters are offered this magazine on a gratis basis by writing on their letterhead to the Editor, "Heat Treat Review," Surface Combustion Corporation, Toledo 1, Ohio.

Automatic Temperature Control

Wheelco Instruments Company, Chicago, has just released a new two-color bulletin describing their Model 292 Capacitrol.

The Model 292 Capacitrol is a completely self-contained indicating deflection type instrument operating with the well-known Wheelco Electronic Link—for measurement and automatic control of temperatures on any type of heating equipment.

This bulletin presents the design, measuring circuit and control system features responsible for the instrument being selected as a standard accessory by leading manufacturers of modern industrial furnaces, ovens, vats, kilns, plastic machines, etc.

A separate price list includes a listing of standard scale ranges.

Request Bulletin 292-1 from the Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Illinois.

Standard Rated Furnaces for Tool Room Heat Treating

A new illustrated Bulletin, SC-151, describing the complete line of "Surface" Standard Rated Furnaces for every tool room heat treat requirement is now available from Surface Combustion Corporation, Toledo, Ohio.

Emphasizing methods of precise heat treatment for maximum tool life, this bulletin describes controlled atmosphere furnaces and generators in addition to direct-fired, forced convection and pot furnaces.

Reviewed in detail are complete controlled atmosphere furnaces of horizontal and vertical types, with prepared atmosphere generators for clean hardening and annealing high speed steels, oven type direct fired furnace for hardening and annealing or other general heat treatments, oven and pit type forced covection furnaces for all tempering and drawing requirements and pot furnaces of rectangular or circular type for salt bath drawing and nitriding.

The back page of this bulletin contains a hardness conversion table for handy reference in tool room and laboratory.

For copies of this Bulletin SC-151, write direct to Surface Combustion Corporation, Toledo 1, Ohio.

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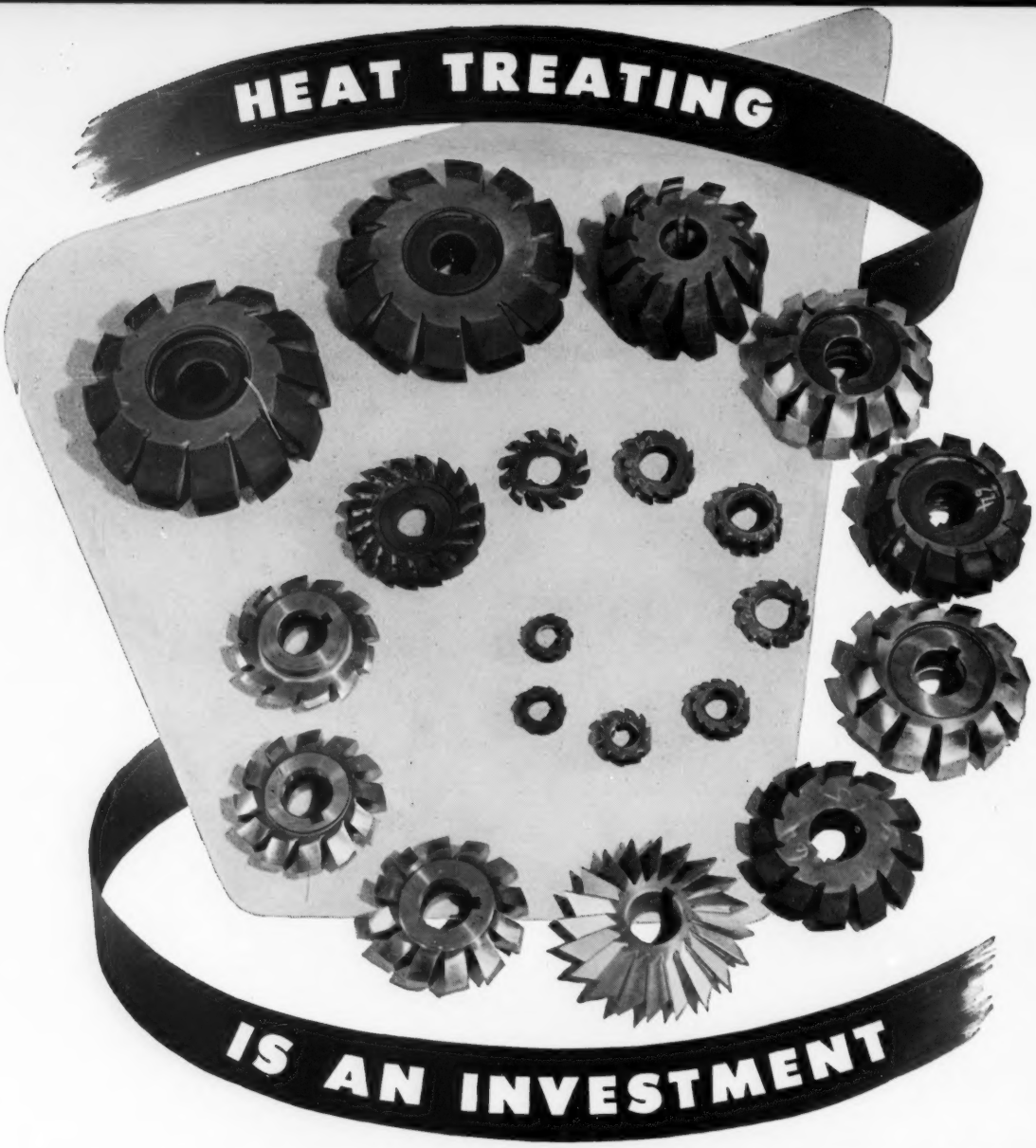

Depending on the shop that is doing it, HEAT TREATING can be just "another job" . . . OR, A REAL INVESTMENT!

These cutting tools, for example, represent top-grade tool steel, plus many skilled man-hours . . . they cost real money. The heat treating means only a few cents more by comparison. But in those few cents can be represented many hours of dependable tool service, or the failure of the tool after only a short period of use.

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175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
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Also available in pellet or liquid form.

FREE —Tempil® "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

METAL & THERMIT CORPORATION

100 EAST 42nd STREET
NEW YORK 17, N. Y.

Editorial (cont.)

the metallurgical intricacies of Government specifications.

Being a specialist, he can get into production quickly. His facilities, old or new, may often be used to take care of the needs of several different contracts at one time, thereby avoiding duplication and wasted time and material. Operation is commonly twenty-four hours a day and perhaps seven days a week. New equipment added to his plant is generally acquired by the Commercial Heat Treater and so increases the facilities available to his local area after the emergency has passed.

Many striking instances of saving accomplished by subcontracting heat treating to Commercial Heat Treaters exist. To cite only one case, a war contractor considered the installation of heat treating equipment which would have cost $75,000. In addition to this expenditure, it would have been necessary to house the new department, thereby adding another $30,000 to the investment. Fortunately, the local Commercial Heat Treater was called in. He completed the entire heat treating order at a cost of $10,000. No additional facilities were required. The job was finished before the promised delivery date of the new equipment.

Today it is vitally important to conserve materials, time and money. Sound practice now will do much to expedite defense production, protect the taxpayer and mitigate the chaos of disorganized markets later.

A mother was having a lot of trouble breaking her child of sucking her thumb. Most of the time she was patient but occasionally she was irritable. Finally she just exploded.

She said, "If you don't stop sucking your thumb you will blow up and burst."

A day or so later they were riding on a bus sitting opposite a woman who was well along with a child as the saying goes. There was a sudden hush as the little girl looked at the woman with a knowing eye and said, "I bet I know what you've been doing."

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and
materials processing

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Materials & Methods

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What kind of editorial coverage does M&M give these technical men on metal treating *specifically?*

Ninety-eight articles on metal treating appeared in the editorial pages of MATERIALS & METHODS during 1950. In an average of eight or more articles every month M&M brings its readers highly-informative, *continuing* editorial coverage of the methods for changing or improving the properties of engineering materials.

•

Materials & Methods

The Magazine of Materials Engineering

A REINHOLD PUBLICATION

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Thermo-couplettes (cont.)

line" control. The Wheelco Capaciline is a simple low-cost supplementary control device which anticipates the fuel needs of controlled heating equipment.

By anticipating the heat transfer lags (thermoinertias), it automatically reduces to a minimum the on-off variations of a control instrument above and below the preset control point, thus enforcing a straight line control on the heating variable.

The Capaciline may be used to add the equivalent of proportioning control to any type of heating equipment with conventional "on-off" control. Control with the Capaciline over ovens, furnaces, kilns, vats, molding or extrusion machines means a saving of fuel, elimination of spoilage, prevention of "over or undershooting" and provides continuous uniform production at very low cost.

There are no tubes, cams or motors in the Capaciline—it is operated through a very simple electrical circuit. The Capaciline is available as a small self-contained unit or as a built-in feature of Wheelco's electronic controllers and strip chart recorders.

* * * *

Nut Shells, Corn Cobs or Dry Ice Suggested for Polishing

The old foundrymen's tumbling barrel may be going to get a new lease on life. Improved polishing agents can produce fine, mirrorlike finishes on metal and non-metallic parts at a fraction of the cost required by hand polishing according to Enthone, Inc., New Haven, Conn. The trick is to polish large numbers of parts at one time by using a rotating barrel containing an abrasive or polishing medium—allowing the resultant rolling-tumbling action between the parts and the abrasive to do the polishing.

New abrasive mediums now include dry ice, nut shells, stones, steel balls, cinders, cracked corn, ground corn cobs, sand and many other materials. Each is useful to do a different kind of job or to produce a different degree of finish. Possible applications are seen in cleaning and polishing heat treated parts.

Personals (cont.)

ammonia and natural gas which permits Metal Treating, Inc., to carburize, cyanide and heat treat in the same unit by varying the atmospheres.

* * * *

Mr. and Mrs. C. Wm. Derhammer announce the engagement of their daughter Betty Jane to Gerald R. Knudson, Jr., son of attorney Gerald R. Knudson of Los Angeles. She is a graduate of U.S.C., and a member of the Delta Gamma Sorority. He is an alumnus of U.C.L.A. and a law student of U.S.C., is a Phi Delta Theta, and served with the U. S. Army during World War II. They will be married June 16th in the Chapel of the Hollywood Presbyterian Church.

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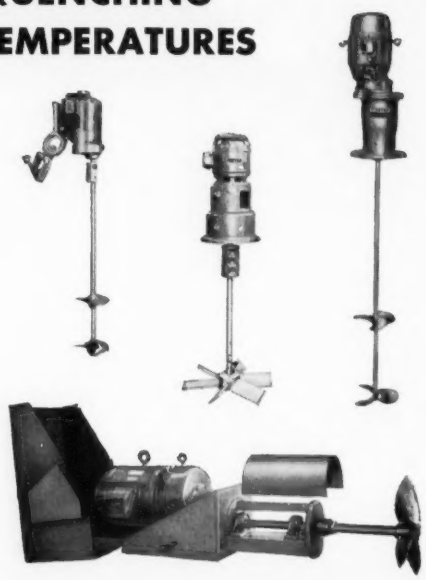

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For fast, accurate, selective heating—controlled in both depth of penetration and area covered—investigate the Lindberg Induction Heating Units. You will profit from their rugged ability to deliver 24 hour a day operation—day after day. Ask for Bulletin 1440.

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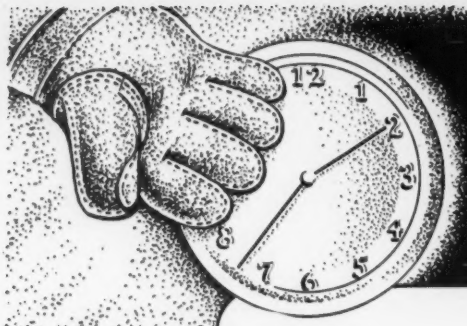

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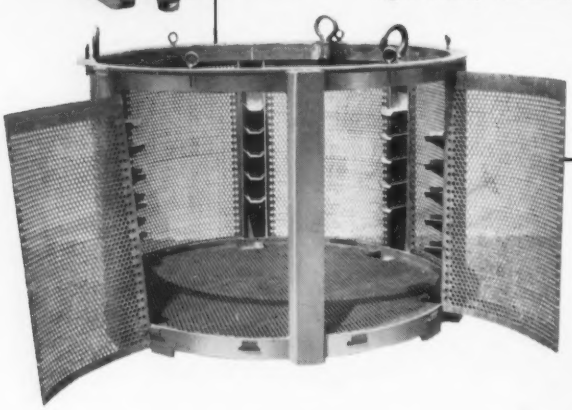
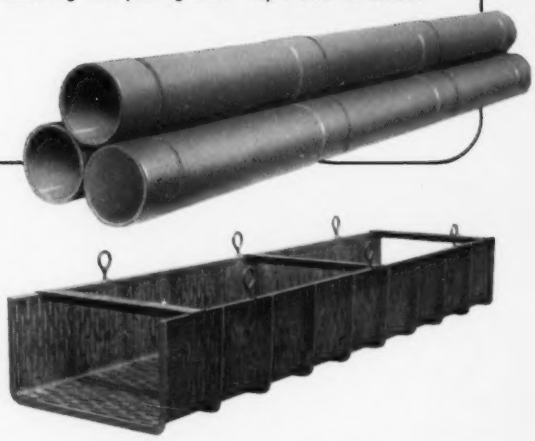
Left bottom, special basket for aircraft parts; movable sides and trays.
Right top, annealing tubes for steel mills. Only ¼" alloy; years of service.
Right bottom, combination annealing and pickling rack. Top braces removable.





In addition to the savings in handling time, PSC light-weight annealing containers effect four other substantial economies. First, being so much lighter in weight, they attain pot heat in less time; PSC installations have shortened heating cycles as much as 5 hours. Second, fuel savings; a recent study showed a $40 saving per anneal. Third, being less bulky, PSC units increase furnace capacity. Fourth, their much longer service life cuts replacement costs.

Standard and Special Types for Every Purpose

PSC welded alloy heat-treating equipment is furnished in any size, design or metal specification: annealing and carburizing boxes, covers, baskets, racks, tubes, retorts, etc. As a pioneer of welded alloy units, we offer a wealth of experienced engineering assistance. Send blue prints or write as to your needs.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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